

**DATA QUALITY SUMMARY REPORT
FOR OZONE DATA COLLECTED BY SONOMA
TECHNOLOGY, INC., DURING THE CALIFORNIA
REGIONAL PM₁₀/PM_{2.5} AIR QUALITY STUDY**

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1. INTRODUCTION AND OBJECTIVES

The purpose of this Data Quality Summary Report is to provide data users with an understanding of the quality of ozone data collected by Sonoma Technology, Inc. (STI) for the California Regional PM₁₀/PM_{2.5} Air Quality Study (CRPAQS). **Table B-1** lists the operating sites and dates for ozone concentration measurements during CRPAQS. This report provides summary information on data completeness, lower quantifiable limit (LQL), accuracy, and precision. Ozone concentrations were measured with 1-minute time resolution and averaged to 5-minute and 60-minute values. Only 5-minute and 60-minute average data were delivered. Data completeness was calculated for both 5-minute and 60-minute data, while LQL, accuracy, and precision were calculated using nightly span data and are applicable to both 5-minute and 60-minute data. Data completeness was calculated for all sites based on data delivered to ARB; the start date/time indicates the beginning of valid data, continuous until the stop date/time. Data validation suggested that all ozone instruments performed similarly; thus, Angiola was used as a representative site to calculate LQL, accuracy, and precision for all ozone monitors operated by STI in the study.

Table B-1. Location and duration of ozone measurements made by STI during CRPAQS.

Site	Start Date/Time	Stop Date/Time
Angiola Trailer	1/22/00 00:00 PST	2/21/01 2:40 PST
Angiola 100-m Tower	12/4/00 22:10 PST	2/8/01 23:55 PST
Sierra Nevada Foothills	12/01/00 00:00 PST	2/13/01 14:40 PST

Several other documents are available from which to obtain information about the CRPAQS field study and data processing. Sampling locations are described in Wittig et al. (2003). Quality control screening procedures are summarized by Hafner et al. (2003). Results of systems and performance audits and intercomparisons are provided by Bush et al. (2001).

The data quality objectives (DQOs) for ozone, in accordance with the CRPAQS Quality Integrated Work Plan (QIWP) (1999), are shown in **Table B-2**. The Angiola Trailer data met the CRPAQS DQO criteria for all parameters but the LQL.

Table B-2. Data quality objectives for ozone data collected during CRPAQS.

Data Quality Metric	CRPAQS Objective
Completeness	90%
Lower Quantifiable Limit	1 ppb
Accuracy	3 ppb or 10%
Precision	1 ppb

2. DATA COMPLETENESS

Data completeness for all ozone measurement sites for both 5-minute and 60-minute data is detailed in **Table B-3**. Data capture quantifies the percentage of total records received versus the number expected during the “period of operation” defined by the start and stop dates/times in Table B-1; the start date/time is the first instance of valid data, and the period of operation is continuous until the stop date/time. The number of valid data points is divided by the number of captured data points to calculate the data recovery. Validity is defined for this calculation as any data point that has a quality control flag of V0 (valid) or V1 (valid but comprised wholly or partially of below-MDL data). Details of data validation are included in Hafner et al. (2003).

Table B-3. Ozone data completeness values for each site.

Monitoring Site	Total No. of Records	No. of Expected Records	Percent Capture ^a	No. of Valid Records	Percent Recovery ^b	No. of Suspect Records	No. of Invalid Records	No. of Missing Records
Angiola Trailer (5-min)	114,081	114,081	100%	99,238	87%	3,574	8,272	2,997
Angiola Trailer (60-min)	9,507	9,507	100%	8,475	89%	308	503	221
Angiola 100-m Tower (5-min)	19,030	19,030	100%	18,152	95%	2	186	690
Angiola 100-m Tower (60-min)	1,586	1,586	100%	1,513	95%	1	19	53
Sierra Nevada Foothills (5-min)	21,489	21,489	100%	20,321	95%	6	1132	30
Sierra Nevada Foothills (60-min)	1,791	1,791	100%	1,738	97%	2	51	0

^a % capture = total number of records/expected records*100%.

^b % recovery = number of valid records/total number of records.

Overall ozone data completeness was good at all sites. All sites had 100% data capture rates. Data recovery rates ranged from 87% (Angiola, 5-minute) to 97% (Sierra Nevada Foothills, 60-minute). The Angiola Tower and Sierra Nevada Foothills data exceed the CRPAQS DQO recovery rates while the Angiola trailer data are 1% to 3% below.

3. LOWER QUANTIFIABLE LIMIT

The LQL is the lowest concentration in ambient air that can be measured when processing actual samples. Sources of variability that influence the monitored signal at low concentrations include instrument noise and atmospheric variability. As a measure of the instrument noise, two times the standard deviation of 5-minute zero calibration data was used to

estimate the LQL. Equation B-1 shows the LQL calculation. **Table B-4** shows the LQL for the ozone instrument at Angiola. The LQL does not meet the CRPAQS DQO.

$$LQL \approx 2s = 2\sqrt{\frac{\sum (O_3 - \bar{O}_3)^2}{N-1}} \quad (\text{B-1})$$

where:

\bar{O}_3 = mean ozone concentration
N = number of zero check measurements
 σ = standard deviation

Table B-4. LQL based on zero calibration checks used for the 5-minute ozone concentrations at the representative site, Angiola.

No. zero checks used	LQL (ppb)
205	1.9

4. ACCURACY

Nightly span checks were performed at 80 ppb ozone using the on-site calibrator. These nightly checks can be used to evaluate the accuracy of the instrument throughout the study. Accuracy can be expressed in terms of the 95% confidence interval (CI). For STI's ozone measurements, the 95% CIs of the span measurements were calculated from the differences between monitor response and known concentrations provided by the nightly automatic span checks performed during routine operation. The 95% CI approximates the accuracy of the data as shown in Equation B-2.

$$\text{Accuracy} \approx 95\% \text{ confidence interval} = 1.96 \left(\frac{s_{\text{span}}}{\sqrt{N}} \right) \quad (\text{B-2})$$

where:

$$s_{\text{span}} = \sqrt{\frac{\sum (x - \bar{x})^2}{N-1}}$$

$$x = [O_3]_{\text{cal}} - [O_3]_{\text{measured}}$$

$$\bar{x} = \frac{\sum ([O_3]_{\text{cal}} - [O_3]_{\text{measured}})}{N}$$

$[O_3]_{\text{cal}}$ = ozone concentration output by the calibrator
 $[O_3]_{\text{measured}}$ = ozone concentration measured by the analyzer corrected by calibrations applied to data.

Generally, one 5-minute average of span check data was obtained each night. A small number of span checks was excluded because the instrument or the calibrator malfunctioned. The 95% CIs and the number of nightly average span values used to estimate the CIs for ozone at Angiola are provided in **Table B-5**. The accuracy computed using span check data meets the CRPAQS DQO.

Table B-5. Accuracy at 80 ppb O₃ and number of span check data points used for the 5-minute ozone concentrations at the representative site, Angiola.

No. of Spans Used	Accuracy at 80 ppb O ₃
199	0.8 ppb

5. PRECISION

The consistency of the nightly span concentrations provides a measure of precision in the ozone analyzer measurements. The precision was evaluated by comparing the measured concentration during the span check to the average measured concentration during span checks for the entire study. The CI at a 95% confidence limit of the span measurements was used to estimate the precision of the data as shown in Equation B-3. This is applicable to both 5-minute and 60-minute data.

$$\text{Absolute Precision} \approx \text{CI} = 1.96 \times \frac{\sigma_{\text{measured}}}{\sqrt{N}} \quad (\text{B-3})$$

where:

$$\sigma_{\text{measured}} = \sqrt{\frac{\sum ([\text{O}_3]_{\text{measure}} - [\overline{\text{O}_3}]_{\text{measured}})^2}{N - 1}}$$

All the ozone concentrations in Equation B-3 refer to the concentrations measured during the span checks. **Table B-6** shows the precision calculated for the representative site, Angiola. The precision of the ozone measurements meets the CRPAQS DQO.

Table B-6. Precision and the number of span measurements used to calculate the precision of the 5-minute ozone data at the representative site, Angiola.

No. of Spans Used	Precision (ppb) at 80 ppb O ₃
199	0.26 ppb

6. REFERENCES

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